Ethics, Identity, and Political Vision: Toward a Justice-Centered Approach to Equity in Computer Science Education

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In this essay, Sepehr Vakil argues that a more serious engagement with critical traditions in education research is necessary to achieve a justice-centered approach to equity in computer science (CS) education. With CS rapidly emerging as a distinct feature of K–12 public education in the United States, calls to expand CS education are often linked to equity and diversity concerns around expanding access to girls and historically underrepresented students of color. Yet, unlike other critical traditions in education research, equity-oriented CS research has largely failed to interrogate the sociopolitical context of CS education. To move toward a justice-centered approach to equity, Vakil argues, we must simultaneously attend to at least three features of CS education: the content of curriculum, the design of learning environments, and the politics and purposes of CS education reform. While there are many avenues of critical inquiry within and across each of these topics, the focus in this essay is on the role of ethics in the curriculum, the role of identity in CS learning environments, and the significance of a clear political vision for CS education.

Keywords: computer science education, critical theory, STEM education, ethics, sociocultural theory

> No one wants to hear why you are behind. Run faster, jump higher . . . We are here to talk about new possibilities for you, next door . . . Next door to you is the largest, most robust industry in the whole world called Silicon Valley. And somehow, someway, it has passed over you . . . So buckle down and get on up! And make it happen! . . . [Prep] will be a resource for Silicon Valley! . . . If I learn computer science . . . I can see the goal! The goal is Google! The goal is Facebook! The goal is Microsoft! (Vakil, 2016)

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Civil rights leader Jesse Jackson spoke these words during a school assembly at Prep, a large, racially diverse urban school in the San Francisco Bay Area.[1] Jackson's visit to the school came on the heels of a recently announced partnership that he helped broker between Intel and a computer science (CS) learning academy at the school, reflecting the increasingly powerful presence Silicon Valley is playing in recent efforts to bring coding and computer science to classrooms all over the country. Indeed, these efforts have seen considerable success, particularly in recent years. For instance, Google and Gallup recently partnered to assess existing opportunities to learn CS in K–12 public schools in the United States and found that 60 percent of high school principals reported at least one CS class available in their schools (Google & Gallup, 2015). The study also examined public perceptions of CS, finding that the "vast majority" of teachers, parents, and administrators believe that CS is "more important than or just as important as required courses like math, science, history, and English" (p. 3). Furthermore, hundreds of school districts across the country, including in major cities such as Los Angeles, New York, and Chicago, are already at various stages of implementing CS in their core curriculum (Rampell, 2014), and in some cases requiring CS for graduation (Dickey, 2016).

Nationally, CS education has been a rare bipartisan issue in a time of historic political tension. For instance, Computer Science for All was a key policy initiative for President Barack Obama (Smith, 2016), but President Donald Trump has also called for increased expenditures for CS education, a rare example of political continuity between the two administrations (Dickey, 2017). Given how forcefully and rapidly CS education has made its way into public education, and the consciousness of the American public, a basic yet significant set of questions must be asked: What are the goals and values of CS education? And how have these goals and values shaped the nature of current curricular and pedagogical approaches?

With calls for expanding CS education, including in President Trump's recent memorandum to the Department of Education, as well as in the rhetoric of companies like Intel partnering with urban school districts, lies a rationale for CS education that draws heavily on narratives of diversity and inclusion—the idea that expanding CS education for all children is not just a good idea but one that is morally imperative and part of broader efforts to expand racial and gender equity in schools and society. Yet, at the same time, as seen in Jesse Jackson's comments, the rationale for CS education is also commonly linked to the economic needs of technology companies ("[Prep] will be a resource for Silicon Valley . . . The goal is Google! The goal is Facebook!").

In this article I use critical pedagogy and critical race theory (Freire, 2000; Giroux, 1989; Ladson-Billings & Tate, 1995) to argue that linking the need for CS in schools to the interests of multinational corporations obscures the sociopolitical implications, relevance, and, ultimately, liberatory possibilities of teaching and learning CS. A fundamental premise underlying my analysis

is that computer science is a discipline comprising a body of knowledge and set of practices in a world where technology is not only ubiquitous but profoundly consequential across multiple dimensions of the human experience. Technological advances—and therefore the science, theory, and design that make them possible—are intertwined with ethical and political issues such as debates around national security and the rights of citizens, the illegal monitoring of activists through technology-enabled surveillance, the hacking of electronic voting systems, the use of digital technologies and social media in popular uprisings, or the role of computer systems in disaster relief efforts, to name just a few examples. Therefore, I agree with the emerging coalition of policy makers, educators, and researchers who assert the need to expand the profile of CS education in public schools and broaden participation so that *all* children have access to rich and rigorous CS learning. However, to do justice to CS as a discipline that is linked with systems of power, as well as to the exciting possibilities for learning computer science as part of a project of justice and liberation, I argue for a radical rethinking of how we conceptualize the meanings and purposes of equity.

I bring multiple professional as well as personal perspectives to the discussion around the sociopolitical aims and objectives of CS education in particular and to the broader purposes of science and technology more generally. As a scholar and educator in the field of learning sciences and STEM education, I conduct critical ethnographic research exploring the cultural and racial politics of CS (and engineering) education and participatory design research conducted in partnership with marginalized communities to reimagine and implement transformative learning experiences in CS/engineering disciplines.

My concerns for transformative CS education, however, are also rooted in my life experiences and identity as a scholar of Middle Eastern descent. I was born in Iran in 1983, during the eight-year Iran-Iraq war that claimed upward of one million Iraqi and Iranian lives. During this time, my father was a high school mathematics teacher, and my mother volunteered in hospitals. Many of the young soldiers my mother cared for were injured by chemical weapons supplied to Iraq by the United States (McNaugher, 1990) and delivered with the aid of advanced satellite technologies (Segal, 1988). Though rarely discussed in these terms, the algorithms and computer codes that aided those systems, and the computer scientists and engineers responsible for the design and development of those systems, in my mind, share blame for the human suffering my mother bore witness to in Iranian hospitals. My concerns around the potential for technology to be destructive are therefore deeply informed by a political and personal understanding of how modern warfare is often aided by advanced technology systems, the direct result of knowledge and practices related to CS and other STEM disciplines.

This essay is equally guided by a critical hope and optimism regarding the transformative potential of technology. While mindful of what technology

critic Evgeny Morozov (2013) has called "technological solutionism," the false idea that we can solve all societal problems through devices and algorithms, I hold on to the radical possibility of democratizing and humanizing technologies that can contribute to a vision for a more peaceful and harmonious world. I draw great inspiration from the many current examples (e.g., technologies that aid the blind and deaf; connect, empower, and/or protect grassroot activists; are necessary for disaster relief efforts; enable scientific research and discovery) but even more so from the yet-to-be-dreamt-of (let alone engineered) future technologies rooted in ethically expansive notions of creativity, sustainability, morality, and freedom. These dual sensibilities—caution against the oppressive nature of technology and critical hope regarding what is yet to be—inform the ideas I present here.

In this essay I argue for a decisive conceptual pivot in how equity is conceptualized and enacted in CS education research and practice. I advance a theoretical framework that highlights distinctions between dominant and what I refer to as justice-centered conceptualizations of equity in CS. The framework delineates differences across three components of CS education: representations of ethics in CS curriculum, the role of identity in learning environments, and political visions for CS education. Ultimately, I argue that a justice-centered lens enables us to examine tensions and explore new possibilities for how equity can be conceptualized and actualized in CS education research and practice. The framework pushes us to consider the contradictions and limitations of dominant approaches and, importantly, to imagine new possibilities for transformative and emancipatory CS education.

Before presenting the framework, I provide a selective and critical review of CS education research, focusing in particular on how current and dominant approaches address issues of ethics, identity, and politics in both theory and practice. In constructing my characterization of dominant approaches, I draw from research, policy, and curriculum documents that have a significant footprint in the CS education landscape.

Taking a Critical Look at CS Education

Contemporary research in CS education spans a diverse and broad set of educational issues and contexts and is comprised of a scholarly and practitioner community drawing on diverse pedagogical, theoretical, and methodological traditions. Research in CS education has addressed topics such as curriculum development, teaching, learning, and the design of tools and learning environments that foster computational thinking and practices across a wide range of contexts (e.g., Carver & Klahr, 1986; Denner, Werner, Campe, & Ortiz, 2014; Grover, 2014; Kafai, Fields, & Burke, 2010; Lewis & Shah, 2015; Wing, 2006). Reflecting the national conversation on expanding access to CS, there is also a growing number of scholars in CS education who empirically examine issues of (in)equity and diversity. For instance, scholars have documented the

lack of CS learning opportunities and course offerings in schools with high proportions of students of color (Margolis, Goode, & Chapman, 2015; Google & Gallup, 2015) and the often-subtle mechanisms through which pathways to CS courses or academies learning become racialized and therefore restrictive for students of color in diverse schooling contexts (Margolis, Estrella, Goode, Holme, & Nao, 2010; Nasir & Vakil, 2017). Other studies have examined how pedagogical practices enable or constrain the equitable distribution of learning opportunities within classrooms (Denner et al., 2014; Fields & Enyedy, 2013; Lewis & Shah, 2015; Watkins & Watkins, 2009) and the related issue of the shortage of certified/qualified CS teachers (Ladner & Israel, 2016; Lang, Phillips, & Stephenson, 2013). Scholars have also studied how societal stereotypes, as well as the availability and quality of out-of-school technology-specific learning opportunities, play a significant role in shaping student interest and identity in CS-related practices such as computer programming and design (Barron, 2006; Cheryan, Master, & Meltzoff, 2015; Kafai et al., 2010).

Equity scholars have contributed immensely to the emerging field of CS education, and collectively they provide a foundation that new forms of critical analysis may build on. Yet, if the field of CS education is to realize its potential as a force for justice in schools and society, a deeper and more critical engagement with the meanings and purposes of equity, beyond notions of inclusion and representation, is imperative. A justice-centered approach to equity must simultaneously attend to at least three features of CS education: the content of curriculum, the design of learning environments, and the politics and purposes of CS education reform. While there are many possibilities for critical inquiry within and across each of these topics, I focus here on the role of ethics in the curriculum, the role of identity in CS learning environments, and the significance of a clear political vision for CS education.

The Role of Ethics in CS Curriculum

The political, moral, and ethical dimensions and challenges in computing are far-reaching, ubiquitous, and increasingly complex, particularly in our current sociopolitical moment. Even a cursory review of recent events, such as the ongoing investigations into possible Russian hacking of the 2016 presidential election, the specter of an online Muslim registry, or broader public concerns about mass surveillance of citizens and breaches of privacy, makes evident the complex ethical questions that arise with respect to the development and application of new technologies, within which computing and computer science play a vital role. Yet, within CS education research and practice, questions of ethics are commonly framed through an individualistic lens that presents ethics as primarily about the decisions of good and bad actors. Technology ethicist Joseph Herkert (2005), drawing on the seminal work of political philosopher Langdon Winner (1990), characterizes this sort of individualism as “microethics,” in contrast to the “macroethics” of engineering, such as broader discussions of how technologies impact global systems and

sustainability and, more generally, the complex sociopolitical systems in which advanced technologies are both embedded within and contribute to shape (Conlon & Zandvoort, 2011).

In the world of CS curriculum, though, microethics prevail. This can be seen in how ethics are represented in the CS standards produced by the Computer Science Teachers Association (CSTA) in 2011 (CSTA Standards Task Force, 2011), as well as in the 2016 version of the Exploring Computer Science (ECS) curriculum. While the CSTA has recently produced a revised set of standards (CSTA Standards Task Force, 2017), I focus here on the 2011 standards due to the role they played in articulating foundational learning goals and objectives on which many subsequent CS curriculum efforts were based. At the high school level, the 2011 standards span three discrete courses: Computer Science in the Modern World (grades 9 and 10), Computer Science Concepts and Practices (grades 10 and 11), and Topics in Computer Science (grades 11 and 12). The standards identify five strands that run through each of the three courses, one of which is "Community, Global, and Ethical Impacts." However, only in the introductory course, Computer Science in the Modern World, does the word *ethics*, or related concepts, show up in the course description, and then in its last sentence: "Finally, they should understand the social and ethical impact of their various choices when using computing technology in their work and personal lives and the choices that have already been made for them by those who develop the technologies they use" (CSTA Standards Task Force, 2011, p. 9). No such reference to ethics or ethical issues is made in the other two course descriptions, which were designed with advanced CS students in mind. The descriptions for these courses emphasize an "in-depth study of computer science" and "algorithmic problem solving" in the context of "real-world problems" (Computer Science Concepts and Practices) and "depth of study in one particular area of computing" (Topics in Computer Science).

Later in the document, each of the five strands is more fully articulated. Despite being absent from the descriptions of the more advanced courses in the three-course high school sequence, the "Community, Global, and Ethical Impacts" strand is explained as a "fundamental aspect of CS at all levels." The central concept of this strand is couched in terms of individual choices and the notion of being "responsible citizens in the ever-changing digital world":

> As soon as students begin using the Internet, they should learn the norms for its ethical use. Principles of personal privacy, network security, software licenses, and copyrights must be taught at an appropriate level in order to prepare students to become responsible citizens in the modern world. Students should be able to make informed and ethical choices among various types of software such as proprietary and open source and understand the importance of adhering to the licensing or user agreements. (CSTA Standards Task Force, 2011, pp. 11–12)

In the context of the Internet, the explicit framing of ethics as confined to the "choices" of individual students obscures the Internet's contested and com-

plicated relationship with power, historically and in the present. For instance, it precludes the possibility of engaging the economics and politics inherent in ongoing debates on net neutrality (Fung, 2017) or the history of how US government and military interests contributed to early research on connected devices and networks, which became the technical foundation for the Internet. Rather, the Internet is presented as ahistorical, apolitical, and neutral, a preferred state that can be maintained if only students make “informed” and “appropriate” decisions. Further, by examining specific CS curricula, such as ECS, we might better understand how the framing of ethics shapes possibilities and trajectories for learning in CS classrooms. I choose ECS for analysis primarily because it has a reputation within the CS education community for its emphasis on equity and culturally relevant pedagogy. In this way, one might look to ECS as being at the forefront of developing curriculum materials that meaningfully connect CS concepts and practices to broader societal issues, including ethical and political topics. Developed by teachers and researchers at the University of Oregon and UCLA, and supported by the National Science Foundation (NSF), ECS (2016) is predicated on the idea that computing is a social phenomenon and that computing education should be socially and culturally relevant.

Furthermore, there are multiple explicit references to questions of ethics as central to the learning objectives of the curriculum: “Students will also be introduced to topics such as interface design, limits of computers and societal and ethical issues” (p. 5). Yet, although references to ethics appear throughout the document, they do not figure prominently until the section on “Societal Impacts of Computing,” one of seven content areas the course is organized around. However, even within this section, ethical issues with respect to technology are represented primarily as a question of individual behavior and choice: “Students study the responsibilities of software users and software developers with respect to intellectual property rights, software failures, and the piracy of software and other digital media” (p. 27). Perhaps what best illustrates the individualistic framing of ethical topics in the ECS curriculum is found in the final project description. The final project provides students with four options, including “an ethical dilemma website,” in which students are given one from four presented dilemmas and are prompted to provide reasons for and against making a particular choice within their chosen dilemma. These dilemmas include illegally downloading music over the Internet, selling illegal DVDs to financially support your family, hacking into a school computer system to alter academic records, and buying stolen electronics from an acquaintance (p. 129).

The narrative structure of these ethical dilemmas directs the attention of students to their own potential wrongdoing in future imagined situations where ethical issues unexpectedly appear and therefore frames questions of ethics in CS as limited to the potentially unscrupulous decisions of individual actors when confronted with peculiar situations or “dilemmas.” Further, the

stories frame ethical issues as linked to computing in distal and marginal contexts (e.g., selling illegal DVDs on the street as an example of misuse of a technology) and thereby obscure more fundamental relationships between ethics and technology.

Identity Undertheorized in CS Education

CS learning environments and reform efforts convey messages to students about who they are and who they might become through their participation in the world of computing. In a broad sense, the issue of identity figures prominently in CS education discourses, especially in equity and diversity narratives that make the case for broadening participation to include particular student identities.

In his speech to students at Prep, Jesse Jackson drew on a particular kind of identity politics: "No one wants to hear why you are behind . . . Next door to you is the largest, most robust industry in the whole world called Silicon Valley. And somehow, someway, it has passed over you" (Vakil, 2016). It does not require much imagination to recognize that the "you" is directed at the predominantly African American and Latina/o student body at Prep, who, according to Jackson, despite "somehow" being "passed over," should complain less and instead work harder to gain access to Silicon Valley. Similar kinds of identity-based messaging have become part of the CS education advocacy lexicon. Nonprofits, local school boards, policy makers, and corporations like Intel involved in CS reform commonly appeal to broadening participation for "women and underrepresented minorities" as a key goal and organizing principle.

Yet, in the rapidly emerging field of CS education research, while identity often serves as a backdrop (e.g., describing racial demographics of a school site), less frequently do scholars empirically or theoretically address how matters of identity shape learning processes and trajectories of engagement with CS concepts and practices. The lack of attention to identity, in particular around learning and the design of learning environments, is a symptom of a larger problem of CS education researchers having relied primarily on cognitive orientations to learning and been slower to engage with situated or sociocultural perspectives (Grover & Pea, 2013).

Research on the teaching and learning of CS traces back to the pioneering work of Seymour Papert (1980), whose work focused on helping children develop procedural thinking through LOGO programming. The following decades of CS education research similarly focused on understanding the mental and cognitive processes deemed critical in computer programming (e.g., abstraction, decomposition, recursive and iterative thinking) as well as the development of tools and programs that aided in the development of these processes. Over time there was an increasing recognition that focusing solely on computer programming obscures other important aspects of learning and doing computer science (Resnick & Siegel, 2015). Jeannette Wing

(2006) introduced the term "computational thinking" as a way to build on but also move past an understanding of CS as being limited to computer programming. Establishing computational thinking as a form of cognition distinct from, say, mathematical or scientific forms of thinking was an important conceptual leap for a field that was seeking to simultaneously develop a knowledge base to inform instructional practices in CS education and also contribute to larger questions of human cognition and thinking (e.g., diSessa, 2001; diSessa & Abelson, 1986; Wilkerson-Jerde, 2014; Wing, 2006).

Even so, though computational thinking represented a significantly expanded view of the work of computer scientists, and despite its undisputed influence on the field, scholarship in the CS education research community has privileged cognitive and mental processes (Grover & Pea, 2013). The theoretical omission of sociocultural and situated perspectives helps explain why, until recently (e.g., Brennan & Resnick, 2012; Kafai et al., 2014), topics such as computational thinking and computational concepts more frequently appear as constructs worthy of empirical examination, while classroom discourse or computational practices are less commonly addressed. It follows that identity—sharing conceptual ties to sociocultural theories that view learning as linked to increasingly sophisticated forms of discourse and participation in communities of practice—has not received serious attention in CS education research.

The failure to substantively engage the role of identity processes, beyond generally limiting the theoretical depth of the field, also creates a vulnerability to deficit discourses regarding students from nondominant communities (Bang & Medin, 2010; Ladson-Billings & Tate, 1995; Martin, 2009; Nasir & Hand, 2006). Take, for instance, the idea of interest. While deficit discourses on girls and underrepresented students of color may assume that these groups lack genuine interest in technology-related practices or hobbies, researchers drawing on sociocultural and ecological theories have demonstrated that interest is not intrinsic but rather emerges in activity from access to material and ideational resources (Gutiérrez & Rogoff, 2003; Nasir, 2011), which in turn creates opportunities for students to develop identities that sustain and propel future learning (Barron, 2006). Thus, failing to attend to identity processes and ways in which learning environments constrain or facilitate access to identities carries important pedagogical implications for how students come to be viewed as interested in technology-related activities and, therefore, the extent to which particular students are deemed worthy of CS and other technology-related learning opportunities (Nasir & Vakil, 2017).

CS Education—Is There a Clear Vision?

The work of early pioneers of computing and CS education, including Papert, Alan Perlis, Alan Kay, and Andrea diSessa, to name a few, was predicated on a genuine sense of wonder and excitement for what computing technologies could offer the world of education and the world of the mind. Although heterogeneous in methodological and epistemological orientations to cogni-

tion and computing, the overarching focus of this wave of work on computing education, spanning the 1980s and early 1990s, was about how computers could potentially expand the range of imaginative and expressive functions of the mind and hold untapped possibilities for the field of education (Guzdial, 2015; Resnick & Siegel, 2015). It is also important to note that in that era, there was not the labor demand that currently exists for computer programmers (Guzdial, 2015). Against this historical backdrop of computing as a means for empowerment and expression, Guzdial (2015) expresses concerns about the more recent goals of CS education:

> Unfortunately, most of a computer science education today is about getting better at producing software developers. The goal is greater productivity of higher-quality software developers. The annual SIGCSE Technical Symposium is mostly a meeting of over 1000 undergraduate computer science teachers, where their shared goal is to provide great teaching to contribute workers to the software industry. (Preface)

Linking the goals of CS education to the needs of industry is ubiquitous in CS education discourse. From Jesse Jackson's blunt statements to students during a high school assembly, to President Obama's Computer Science for All initiative, to the recent announcement by the Trump administration, CS education advocates cite the needs and interests of the technology industry frequently and without hesitation. In the recent NSF solicitation for CS education proposals, a "globally competitive STEM workforce" and "increased economic competitiveness of the United States" are listed as desired broader impacts of successful proposals. The 2011 CSTA standards plainly state that "K–12 computer science courses . . . will help meet the growing demands of the international workforce" (p. 1).

In addition to economic and national competitiveness rhetoric, the political vision of CS education is sometimes expressed in ways that dangerously play into discourses of militarism and American empire. The NSF Computer Science for All solicitation, for instance, in addition to those listed above, includes "improved national security" as a viable broader impact of CS education research proposals. As another example, consider the widely cited report produced jointly by the Association for Computing Machinery (ACM) and the CSTA, entitled *Running on Empty: The Failure to Teach K–12 CS in the Digital Age* (Wilson, Sudol, Stephenson, & Stehlik, 2010), in which, in making the case for CS education, the authors invoke "national security," among other factors:

> Computer Science underpins the technology sector, which has made tremendous contributions to the domestic economy, as well as numerous other economic sectors that depend on innovative, highly skilled computer science graduates. Computing touches everyone's daily lives. Securing our cyber-infrastructure, voting in elections, protecting national security, and making our energy infrastructure more efficient are among numerous issues dependent on computing and a strong computing-savvy workforce. (p. 30)

To some, "improving" or "protecting" national security may appear innocuous, an obviously justifiable and positive stance in support of peace and safety and therefore unworthy of scrutiny or analysis. To others, such as antiwar activists (e.g., Chomsky, 2014; King, 1967; Snow, Soule, & Kriesi, 2008) and scholars of international relations (e.g., Cole & Dempsey, 2006; Katzenstein, 1996), "national security" and "defense" are political and ideological constructions that at best naively assume state interests are aligned with those of the general citizenry and at worst are examples of cunning linguistic manipulation, concealing the militarist and imperialist ambitions of US foreign policy and its corporate partners.

My point is not to call into question the intentions of organizations such as the NSF or the CSTA, both of which have contributed tremendously to the project of advancing CS education as both a public and an educational good. Rather, given prior research demonstrating how discourses of militarism and war have shaped the character of education initiatives, particularly in the related fields of STEM education (Philip & Azevedo, 2017; Vossoughi & Vakil, in press), the framework I offer in this essay asserts the immediate need for the CS education community to collectively, clearly, and unequivocally articulate a political vision for CS learning anchored in principles of peace, antiracism, and justice.

Conceptualizing a Justice-Centered Approach to Equity in CS Education

In articulating a framework for a justice-centered approach to equity in CS education, I draw on and bring together critical theories of learning, identity, and pedagogy, along with theoretical perspectives on the relationships between power and knowledge drawn from the field of science and technology studies (STS). To illuminate substantive differences between a justice-centered approach and the dominant approaches discussed above, I organize the framework across the same three components: representations of ethics in CS curriculum, conceptualizations of identity in CS learning environments, and the political vision for CS education reform (table 1). I draw a stark contrast between dominant and justice-centered approaches to equity for analytical purposes, not to place blame or single out any entity, researcher, or institution. It is important to note that, in practice, competing discourses around equity may often mingle and mix, resulting in complicated ideological formations that become embedded within curriculum documents, research agendas, policy declarations, funding initiatives, and even individuals. Nevertheless, by rendering visible differences between dominant approaches to equity rooted in discourses of inclusion and diversity and justice-centered approaches anchored in critical theoretical perspectives on learning, schools, and technology, I hope that the framework can guide critical reflections on the current state as well as future possibilities of CS education.

TABLE 1 *Dominant vs. justice-centered approach to equity in computer science education*

	Representations of ethics in curriculum	*Identity in CS learning environments*	*Political vision*
Dominant approach	Technology and computing have social implications. Learning activities focus on individual and student choices (e.g., piracy, cyberbullying, obeying copyright laws, responsible social media use). Students are encouraged to be responsible digital citizens.	Learning environments focus on developing students' knowledge, skills, and understanding of CS concepts and practices. Research examines cognition and computational thinking. Role of student identity in learning process undertheorized, resulting in deficit lens on girls and students of color.	CS learning framed as important for global economic competitiveness and national security. Students are encouraged to pursue CS through potential career opportunities in technology companies.
Justice-centered approach	Technology and computing have social and *political* implications. Learning activities focus on individual *rights* and freedoms, and corporate and government responsibilities. Students engage in critique of unethical abuses of technological *power* (e.g., US surveillance state and privacy vs. security debates) and explore the role technology can play in reaching social justice goals.	Learning environments focus on developing students' knowledge, skills, understanding, and *disciplinary identities.* Research explores how to *design learning environments* that are responsive to students' multiple social identities, *including their civic and political identities*.	CS learning framed as important for the *social and economic welfare of historically nondominant students and their communities* (including but not limited to students and communities of the United States). Students are encouraged to pursue CS as part of and connected to *larger struggles for justice and liberation.*

Centering Power in Curricular Representations of Ethics in CS

Critical pedagogy offers the world of education a theory of schooling that links learning and teaching to broader processes of dehumanization, oppression, and liberation (Duncan-Andrade & Morrell, 2008; Freire, 2000; Giroux, 2014). Central to this position is the seemingly simple yet deeply contested and complex idea that knowledge itself is political, and, by extension, so is teaching. In developing an approach to ethics in CS education, I build from

these perspectives as well as from ideas in STS, which help articulate the processes through which culture, society, and history have shaped not only the applications of science and technology but also their epistemological nature and conceptual structures (Hackett, Amsterdamska, Lynch, & Wajcman, 2008; Harding, 1993). From this perspective, addressing ethical issues with respect to technology, and to computing technologies in particular, means considering the sociocultural and sociopolitical contexts in which technologies have been developed and are applied.

This macro approach contrasts sharply with the micro approaches discussed earlier in that ethics are viewed as fundamental to all aspects of teaching and learning CS, not as incidental or tangential scenarios an individual may or may not encounter in her interactions with technology. Rather than being confined to notions of personal responsibility and choice, ethics are situated in larger conversations about the role that new technologies, and CS as a discipline, play in reproducing, sustaining, or resisting social, racial, and political hierarchies. From this perspective, ethics are foremost and always rooted in the analysis and critique of power. In an address at a professional conference in New Zealand, computer scientist Philip Rogaway (2015) forcefully challenged his colleagues for their collective role in helping build the technological capacity for what has become the US surveillance state:

> As computer scientists and cryptographers, we are twice culpable when it comes to mass surveillance: computer science created the technologies that underlie our communications infrastructure, and that are now turning it into an apparatus for surveillance and control; while cryptography contains within it the underused potential to redirect this tragic turn. (pp. 43–44)

From this perspective, knowledge developed by computer scientists is directly linked to technologies used for surveillance and social control and is therefore aligned with a very specific and contested set of political values and interests. From a critical pedagogy perspective, interrogating the relationship between political values and knowledge provides a compelling context to explore ethical concerns related to computing and technology. From a curriculum standpoint, students might engage in activities that explore ethics in relation to institutions, societies, ideology, or epistemological perspectives in CS rather than a focus on the "good" and "bad" decisions individual actors make in their interactions with technology. Additionally, analyses of ethics in curriculum need not be relegated to introductory courses but, rather, can be deeply integrated with content learning around advanced topics in computing.

For example, we might imagine a curriculum unit designed to explore the algorithmic as well as ethical dimensions of cryptography, a subfield of CS focused on developing protocols for secure digital communications. In addition to learning the underlying mathematics and technical features of specific cryptographic protocols, critical educators might also explore the complicated

social and political history of cryptography, including its early use by Nazi Germany during World War II (Hill, 2008). Students might explore, debate, and reflect on how the underlying concepts of cryptography were originally developed and the ways in which political, national, or economic goals shaped the intellectual character of the technologies themselves. Other approaches might entail broader classroom debates about privacy and security, civil liberties, or how computing technologies have been and continue to be used to surveil and suppress dissent, particularly in communities of color and activist organizations (ACLU, 2016; Browne, 2015).

In addition to integrating ethics in CS curriculum through historical, political, and epistemological analyses of specific subdomains of computer science, such as cryptography or artificial intelligence or machine learning, a justice-centered ethics education also addresses the subtle yet sophisticated ways ethics is interwoven with computational concepts and practices. This view is consistent with STS perspectives that technological artifacts, and the computer algorithms undergirding them, are laden with human values and therefore constitute technological encodings of power, race, and culture (Harrell, 2013; Winner, 1990). For example, curriculum designers might create activities for students to consider how psychological research on implicit bias may have implications for the design of algorithms and for the individuals and communities those algorithms may impact. Skillful educators can anchor these discussions in current events, such as recent reports on crime-predicting software used by police departments, anti-immigrant "extreme vetting" technologies called for by the Trump administration (Biddle, 2017), or profit-motivated algorithms used by social media outfits that allow housing advertisers to exclude users by race (Angwin, Tobin, & Varner, 2017). In all cases, through a justice-centered approach, engaging ethics in relation to computing and technology centers and makes visible dynamics of power and raises critical questions about the role of technology in society more broadly.

Moving Beyond Inclusion: Student Identities Matter for Learning and Design

Sociocultural and situated perspectives view learning as a complex process entailing the acquisition of knowledge and practices of a particular disciplinary community, which is in turn linked to a related process of transformation in how individuals understand themselves in relation to the discipline in which they engaged, broadly conceived of as identity development (Barton & Tan, 2010; Nasir, 2011). Despite the ubiquity of calls for diversity and equity in CS education, identity has been less commonly engaged on an analytic or empirical level due in part to the relative underrepresentation of sociocultural and interactional theoretical perspectives in the field. Fortunately, though, this is changing. There is a growing body of work examining sociocultural issues in CS education, including research on how to teach in ways that honor and leverage students' racial, cultural, and gendered identities in the service

of consequential learning and positive CS and STEM identity development (e.g., Nasir & Vakil, 2017; Pinkard, Erete, Martin, & McKinney de Royston, in press; Ryoo, Margolis, Lee, Sandoval, & Goode, 2013; Vakil, 2014).

For example, the ECS curriculum incorporates culturally situated design tools (Eglash, Bennett, O'Donnell, Jennings, & Cintorino, 2006) in multiple student activities, creating learning contexts through which cultural aspects of computing are made visible. Critically, these activities draw on a wide range of cultural practices (e.g., graffiti, skateboarding, and dance) intended to appeal to students who have been historically excluded from CS and STEM disciplines. The educators and researchers involved with ECS have in many ways paved the path for other educators and researchers seeking to explore the role of culturally relevant and other equity pedagogies in CS education and to speak to broader questions of learning and identity specific to the discipline of computer science.

Yet, for CS learning environments to embrace equity from a justice standpoint, we must also take seriously students' *political* identities. In this context, political identity does not require affiliation within partisan politics or even participation in formal democratic processes. Rather, political identity is conceptualized more broadly to encompass one's awareness of and commitment to issues of power and inequality in society (Nasir & Kirshner, 2003; Yates & Youniss, 1998), as well as a demonstrated sense of agency to "imagine a new and different world" (Barton & Tan, 2010, p. 192). In the context of CS, political identity may signal the extent to which students are aware of both the benefits as well as the negative consequences of new technologies, a commitment to using scientific and technical knowledge to improve the human condition, or a general awareness of how computer science as a discipline is interwoven with history, culture, and ideology.

Why does political identity matter for issues of equity in CS education? Isn't focusing on students' cultural, racial, and gender identities enough? These questions, which I anticipate from traditional CS educators and researchers, and even those drawing from sociocultural traditions, are rooted in fears that explicitly engaging in questions of political identity risks politicizing CS education. Informed by critical theories of learning (Philip et al., 2017), a justice lens to equity argues that CS education is *already* politicized. Therefore, carefully examining how students' political identities shape and are shaped by CS learning environments will only deepen our collective knowledge about students' experiences in computer science, a goal few would dispute. Even more importantly, however, I argue that students' political identities are uniquely powerful and typically untapped resources for transformative learning and therefore should be welcomed, respected, and leveraged by CS educators motivated by justice and equity.

To illustrate potential ways political identity intersects with and transforms students' experiences with CS and technology, I provide two stories from research and practice. In the first case I profile Lupe, a high school student

enrolled in the Computer Science and Technology Academy of a diverse urban high school and a research participant in an ethnographic study of learning and identity (Nasir & Vakil, 2017; Vakil, 2016). In the second example I briefly describe a technology project designed by students in a social justice youth nonprofit in the San Francisco Bay Area.

— Lupe

Lupe was one of the few girls of color in the Computer Science and Technology Academy at her school, a position she was keenly aware of, often expressed resentment toward, and yet sometimes demonstrated great pride in. She declared herself a feminist and spoke eloquently about how inequities at her school reflected broader societal injustices. She also was a talented and passionate computer programmer. These identities are all central to Lupe's sense of self. Yet, in reflecting on her experiences in the academy, she often bemoaned how the culture only recognized her interest in computers and technology and superficially acknowledged her gender and racial identity. While she didn't directly address her political or social justice identity, she indicated experiencing a tension between her goals of doing "something good" and her participation in the discipline of computer science:

> I'm at the age where the question "What do you want to be?" is becoming more relevant. I've always been scared that someday I'm going to sell out and do something that I hate. I feel like I even think of computer science like that, like being a part of a huge unfeeling oppressive corporation that makes you money sure, but never does something good.

Critically, interviews with Lupe's teachers in the academy revealed great admiration of her as a highly successful student, yet there was little recognition of her politically focused values and interests and, as a result, little understanding of the very complicated and serious tensions she was experiencing between her political identity and her identity as someone who enjoys and is successful with technology. While we can hope Lupe will be able to pursue her passions—technological, political, and otherwise—in ways that satisfy her evolving desires to do "something good," her case raises important questions about the role CS learning environments play in conveying ideas regarding the values and politics of computer science. What kind of person do you need to be, or will you become, through participation in the discipline of computer science? This is the question Lupe was grappling with, and one that CS education teachers and researchers ought to pay more serious attention to.

— West Side Stories

CS learning environments can also treat students' political identities with respect and pedagogical openness, recognizing students' political experiences, ideas, and literacies as powerful and unique resources for learning and technology design. Consider, as an example, West Side Stories, a recent digital

interactive website produced by the Oakland-based nonprofit Youth Radio, an organization with a long history of offering low-income youth of color opportunities to learn digital and new media literacies (Bliss, 2015; Soep & Chávez, 2010). Seven young people worked with a team of designers and programmers to create an interactive visualization that boldly explores the gentrification of West Oakland.[2] Over the course of several months, youth interviewed longtime residents, debated with one another, and engaged in collaborative design and computer programming, culminating in a web-based artifact that powerfully engages a complex political issue in their community. In this way, Youth Radio facilitated a learning context in which students' political experiences were integral to the framing of the concept and therefore to the design and development of the website. The process of design, in turn, also provided an opportunity to reflect more carefully on the complicated issue of gentrification. In this way, students' political identities were resources for the design process, and the activity of design became a resource for ongoing reflection on sociopolitical issues directly relevant to students' immediate lives.

The case of West Side Stories, and, more broadly, the work of Youth Radio and similar organizations committed to developing young people's technological literacies alongside and interwoven with a political project of social transformation, serves as an important counterexample to CS learning environments that explicitly or implicitly position students' political identities as unwelcome, unnecessary, or both. In contrast, a justice-centered approach engages student identities, including political identities, with respect and dignity. Equity in this context translates to student identities being treated as vitally important in analyses of how students experience the politics and values of CS across a range of contexts and, importantly, also as a recognition of how political identities can powerfully shape the design, goals, and epistemological and emancipatory possibilities of CS learning.

Political Vision of CS Education: Moving Beyond Discourses of Access and Inclusion

In some sense, thinking about how to address ethics in CS curriculum, or how to design learning environments that are respectful of students' identities, are the crucial details to which CS education as a field needs to carefully attend. Yet, without a clear political vision, the individual components of the framework risk becoming isolated efforts and thereby lose their potential to become critical components of a larger effort to significantly refocus the direction of CS education toward justice. Thus, this component of the framework directs our attention to the importance of a clear political vision, an articulation of the philosophical, pedagogical, and educational values and ambitions imagined as desirable or possible in the context of CS learning. Of course, in articulating a stance on ethical issues in computer science, and the role of political identity in the learning process, I have already implicitly referenced a kind of

alternative vision for CS education. Here I make explicit the political commitments underlying a vision for justice in CS education.

I begin with the work of scholars who have raised critical questions regarding the economic and political goals underlying calls to expand STEM education, particularly within low-income communities of color (e.g., Gutstein, 2006; Martin, 2009). Mathematics education researcher Walter Secada (1989) spoke of the "enlightened self-interest" that conflates equity-oriented reform agendas with the human labor priorities of the workforce. Similarly, drawing on the notion of interest convergence, the idea that gains for communities of color often occur where there are concurrent advantages aligned with the political or economic interests of dominant groups (Bell, 1980; Ladson-Billings & Tate, 1995), race and mathematics education scholar Danny Martin (in press) argues that equity for Black students in mathematics classrooms is a delusion. Building from these ideas, scholars are now beginning to examine how dominant discourses position STEM education in service of not only the goals of capital and industry but also those of empire and militarism (Philip & Azevedo, 2017; Vossoughi & Vakil, in press).

Informed by these perspectives, a political vision for a justice-centered CS education agenda refuses cooption by Silicon Valley interests, even when these corporate-school "partnerships" promise lucrative offerings to underresourced schools. Rather, it views these industries and their agendas with skepticism, joining with a long tradition of critical education scholarship and activism that challenges, questions, and resists the influence of corporate and economic interests on education (e.g., Apple, 2013; Giroux, 1989). Where a dominant approach to CS education draws on multicultural discourses of equity and inclusion and ultimately hopes to create pipelines into these industries to increase the number of underrepresented students of color and women in these fields, a justice-centered approach to equity challenges the corporate technology sector on moral, epistemological, and political grounds. How are these companies working to advance social justice locally and abroad? At whose expense do these companies make profit? What ideological and political projects are these industries working in service of? Further, a justice-centered approach to equity in CS education actively resists discourses that rationalize the importance of learning CS in terms of "national security," "defense," or other ideological constructions that conceal nationalistic goals of war and empire. Rather, from a justice lens, the goals of CS education are rooted in a critical praxis of peace and freedom, including conscientious opposition to the development of technologies that advance the goals of militarism, occupation, surveillance, and expansionism.

A political vision for CS education anchored in justice joins with students and their communities to imagine humanistic forms of CS learning unwaveringly motivated by ethical and moral purposes. In a justice-centered CS classroom, students may learn how to conceptualize and design systems that

critique power. Students may work in close collaboration with local organizations to build encryption technologies that safeguard citizens from unlawful government surveillance. Learning environments might extend into the community to create opportunities for students to work in partnership with activists to design and deploy technologies that advance the interests of marginalized groups. Teachers might design online environments where students in distal geographic locations collaborate to use digital and computational technologies toward the development of empowering social networks, leveraging technology in unprecedented ways to create empathy, raise consciousness, and build solidarity. Students may work with health-care professionals to design new technologies for the sick, disabled, or elderly communities or with other teachers and students to dream and design new ways technology might engender transformative learning in classrooms.

In these visions for CS education, ethics do not need to be "included" in the curriculum through stand-alone modules or extra-credit projects, because they will reflect the defining purpose and epistemological center of all learning activities. In these classrooms, students will be respected not solely by interpersonal interactions experienced with other students and teachers but by the humanizing nature of the curriculum and the transformative, affirming learning it gives rise to. Students' identities need not be welcomed in these spaces because one does not need welcoming into her own home. In these homelike environments, learning is organized in ways that seamlessly honor the depths of student experience and the range of identities they carry with them into the learning and design process.

As currently formulated, these visions into future CS learning possibilities rooted in principles of justice might be better characterized as preliminary sketches, requiring refinement, revision, elaboration, and critique, possible only through the collective, participatory, and rigorous processes of research and practice. Yet, these sketches offer an important conceptual starting point anchored by liberatory perspectives on learning and pedagogy and an unequivocal refusal of dominant and exploitative approaches to CS education.

How Do We Get There? A (Somewhat) Hopeful Discussion of Possible Next Steps

I acknowledge that between the current state of CS education as characterized in this essay and the recommended path forward as defined through the justice-centered framework lies what seems to be an insurmountable distance. The pedagogical and philosophical divide may appear irreconcilable, unrealistic, or excessively daunting. These are real concerns that should be taken seriously: to reclaim CS education as a force for justice, there remains a hard ideological, pedagogical, economic, and political fight ahead. Fortunately, though, recent developments within and outside of the CS education community provide some reason for hope, and a place to begin.

K–12 Computer Science Framework

In 2016, a collection of CS education organizations, including the CSTA, Code.org, the National Science and Math Initiative, and the ACM, jointly released the *K–12 Computer Science Framework* (2016), an impressively comprehensive document outlining a set of high-level CS concepts and practices intended to guide the development of future standards and curriculum in local contexts. Although the framework does not explicitly position ethics as embedded within systems of power, it offers a greater recognition of how ethics and technology are intertwined in complex and nuanced ways. Its expanded profile of ethics can be seen in both the number of instances and, more importantly, the manner in which ethical issues are linked to other CS concepts and practices.

For instance, based on our discussion of dominant approaches, one might imagine that references to ethical issues would appear mainly in "Impacts of Computing," one of the framework's five organizing core concepts. However, ethical issues are woven throughout, including in technical content areas such as "Data and Analysis" and "Algorithms and Programming." Regarding the highly politicized debates around mass surveillance, national security, and privacy, in the *Framework*, within the "Data and Analysis" core concept, data collection is described in a way that creates pedagogical openings to more robust discussions of ethics and power:

> Data can be collected and aggregated across millions of people, even when they are not actively engaging with or physically near the data collection devices. This automated and nonevident collection can raise privacy concerns, such as social media sites mining an account even when the user is not online. Other examples include surveillance video used in a store to track customers for security or information about purchase habits or the monitoring of road traffic to change signals in real time to improve road efficiency without drivers being aware. (p. 117)

This concern for the rights and privacy of individuals is a consistent theme across the document. The "Impacts of Computing" core concept, in addition to appeals to individual responsibility and digital citizenship, highlights how policy and legal frameworks intersect with computing in ways that may have serious implications for the rights of individuals.

> Laws govern many aspects of computing, such as privacy, data, property, information, and identity. These laws can have beneficial and harmful effects, such as expediting or delaying advancements in computing and protecting or infringing upon people's rights. International differences in laws and ethics have implications for computing. (p. 121)

There is also a recognition of the ways in which computing technologies can be utilized as instruments of political repression: "Firewalls can be used to block harmful viruses and malware but can also be used for media censorship. Access to certain websites, like social networking sites, may vary depending on a nation's laws and may be blocked for political purposes" (p. 121).

When compared to the 2011 CSTA standards or to the ECS curriculum, these statements represent a notable, though tentative, shift in how ethical ideas enter CS education discourse. I argue that the shift from individual to macro-level ethical issues provides a conceptual opening which critical educators and designers can build on. Further, the shift in how ethics are represented in the *K–12 Computer Science Framework* is indicative of an evolving intellectual community that is engaged in a reflexive process of self-examination and revision.

Organizing a Community Around a Commitment to Justice and Technology

Yet, to find more serious discussions of how technology and computing are embedded and implicated in systems of power, or to seek an intellectual community committed to a radical reimagining of technology and how it may play a role in larger projects of social transformation and liberation, we need to look outside of traditional CS education circles. For example, there are several individuals and organizations working to raise public consciousness regarding potential dangers of new technologies. A report from Harvard University's Belfer Center for Science and International Affairs provides one thorough account of how advances in machine learning and artificial intelligence (AI) "represent a turning point in the use of automation in warfare" (Allen & Chan, 2017, Project Overview). Similarly, a recent video released jointly by University of California, Berkeley, CS professor Stuart Russell and the Future of Life Institute issues a grave warning about the proliferation of autonomous lethal weapons, ominously labeled "killer robots" (May, 2017). There are also technology and civil rights groups, such as Georgetown Law's Center on Privacy and Technology and New York University's Brennan Center for Justice, that have criticized President Trump's vision for "extreme vetting" of immigrants on grounds that the software required would be both technically infeasible and racially discriminatory (Biddle, 2017). More technology researchers are also pursuing these issues. For example, Massachusetts Institute of Technology graduate researcher Joy Buolamwini founded the Algorithm Justice League, an organization focused specifically on how the racial biases and subjectivities of computer scientists become embedded in the code they produce. Collectively, the work of these individuals and organizations help expand and sharpen our understanding of how new technologies are subtly, but deeply, embedded in systems of power and therefore carry significant implications for questions of equity and justice.

There are surely many others who share similar commitments to thinking critically about the role technology plays, and could play, in shaping society for better or worse. There are also education and youth-centered organizations, like Youth Radio, or the work of the Digital Youth Network, led by Northwestern University professor Nichole Pinkard, or Code510, led by UC Berkeley graduate student Sarah van Wart, or TechActivist.org, led by community organizer Idalin Bobé, to name just a few who are engaged in creating educational

experiences in which young people learn how to use and design technologies in ways that are transformational for themselves and their communities. The people and ideas central to these efforts should be viewed as essential to the ongoing discussions about curriculum, learning, and the politics and values of CS education. An important task moving forward, then, is to rethink the boundaries that determine who is and who is not part of the CS education community. Strategically organizing educators, researchers, students, and organizations that share a vision for justice in CS education is an essential next step of the work.

Concluding Thoughts

In this essay I argue for a rethinking of the meanings and purposes of *equity* in CS education discourse. Rather than framing equity in CS education as a matter of increasing the number of underrepresented groups in technology by creating pipelines from low-income urban schools to high-profile corporations, I propose a justice-centered approach to equity that links CS learning to critical pedagogies of freedom and liberation by engaging the ethical and political implications as well as unrealized possibilities for technology to transform and empower communities. I offer a framework that critically examines mainstream CS education research and outlines a vision for CS education rooted in critical theories of learning and pedagogy.

Computer science education will soon be a prominent feature of US public education. The political goals of CS education, explicit and implicit, are as diverse as the stakeholders currently involved—teachers, parents, students, nonprofits, large corporations, the Department of Defense, and others. The fact that CS education is forcefully emerging should be a call to action. And its young, emergent nature opens the window of possibilities, both good and bad, and reflects a wide-ranging set of political interests and ideologies. There is no doubt that dominant elements of the public and private education landscape will vie for maximum influence over the future of computer science education. It is therefore an urgent project of CS education researchers and teachers committed to education as liberation to develop theories and frameworks that challenge dominant trends in this nascent field and to articulate our own visions rooted in commitments toward freedom, human dignity, and justice.

Notes

1. The names of schools and students used throughout the manuscript are pseudonyms.
2. West Oakland is a historically African American neighborhood. In recent years, longtime residents and community members have been displaced due to rising property values triggered by the surrounding technology boom in Oakland and the greater San Francisco Bay Area.

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